

*Conservation Assessment
for
French's Shootingstar (Dodecatheon Frenchii) (Vasey) Rydb.*



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SHAWNEE AND HOOSIER NATIONAL FORESTS



This document is undergoing peer review, comments welcome

This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service - Threatened and Endangered Species Program at 310 Wisconsin Avenue, Suite 580 Milwaukee, Wisconsin 53203.

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EXECUTIVE SUMMARY

This Conservation Assessment is a review of the distribution, habitat, ecology, and population biology of French's shootingstar, *Dodecatheon frenchii* (Vasey) Rydb., throughout the United States, and in the U.S.D.A. Forest Service lands, Eastern Region (Region 9), in particular. This document also serves to update knowledge about the status, potential threats, and conservation efforts regarding French's shootingstar to date. French's shootingstar is a perennial herb that is limited in range to an area just south of the glacial boundary in only six Midwestern and southeastern states in the United States of America, namely, Alabama, Arkansas, Illinois, Indiana, Kentucky, and Missouri. It grows mainly in shaded mostly level sites that are moist or wet in the winter and spring under prominent sandstone overhanging ledges in well-drained sandy soil, and it is most frequently associated with drip-lines at the margin of the ledges. Like other shootingstars, it becomes dormant for much of the year and loses most or all of its above ground parts, making it difficult to determine how many individuals make up a population except during active growth. Globally, its ranking is G3 (vulnerable, globally rare or uncommon). French's shootingstar happens to be most common in Illinois, and, in the state, it is found primarily within the Shawnee National Forest. The species has been included on the Regional Forester Sensitive Species list (RFSS) for both the Shawnee National Forest and the Hoosier National Forest. Its status is secure in Illinois, but the species is considered rare in every other state in which it occurs. It faces several risks that could result in its extirpation throughout its range if it is not properly managed.

In addition to species listed as endangered or threatened under the Endangered Species Act (ESA), or species of Concern by U.S. Fish and Wildlife Service, the Forest Service lists species

that are Sensitive within each region (RFSS). The National Forest Management Act and U.S. Forest Service policy require that National Forest System land be managed to maintain viable populations of all native plant and animal species. A viable population is one that has the estimated numbers and distribution of reproductive individuals to ensure the continued existence of the species throughout its range within a given planning area.

The objectives of this document are to:

- Provide an overview of the current scientific knowledge on the species.
- Provide a summary of the distribution and status on the species range-wide and within the Eastern Region of the Forest Service, in particular.
- Provide the available background information needed to prepare a subsequent Conservation Approach.

NOMENCLATURE AND TAXONOMY

Scientific Name:	<i>Dodecatheon frenchii</i> (Vasey) Rydberg
Common Names:	French's shootingstar (sometimes written as "shooting star" or "shooting-star")
Synonymy:	based on: <i>Dodecatheon meadia</i> L. var. <i>frenchii</i> Vasey (1890) <i>Dodecatheon meadia</i> L. ssp. <i>membranaceum</i> R. Knuth
Class:	Magnoliopsida (Flowering Plants - Dicotyledons)
Family:	Primulaceae (the Primrose family)
Plants Code:	DOFR2 (USDA NRCS plant database, W-7) http://plants.usda.gov/cgi_bin/topics.cgi

There are approximately 15 species of shootingstars (*Dodecatheon*) in North America north of Mexico depending upon differing interpretations. The species have been subdivided into many subspecies and varieties about which there are differences of opinion. This species is often considered to be a close relative of the more common *Dodecatheon meadia* L., Pride-of-Ohio (generally simply called Shootingstar in most areas). The only other shootingstar found in the Midwestern states is *Dodecatheon amethystinum* (Fassett) Fassett, the Jeweled shootingstar. The flower shape suggests a relationship with the genus *Cyclamen*, another member of the same plant family not native to North America, that also has a basal rosette of leaves and petals that are bent back (recurved) at flowering. Recent molecular studies suggest that the Primulaceae is extremely close to the tropical woody family Myrsinaceae, and suggests that *Cyclamen* and *Dodecatheon* may not be as closely related as morphology suggests (Källersjö *et al.* 2000). Instead, *Dodecatheon* and *Primula* appear to be extremely closely related, and, perhaps, congeneric (Conti *et al.* 2000, Mast *et al.* 2001, Trift *et al.* 2002).

Dodecatheon frenchii was named after Southern Illinois University botany professor George Hazen French, who first discovered the plant in 1871 (Post 1996; W-2). While once thought to be a variant of *Dodecatheon meadia*, it is distinct at the genetic level because it is a diploid ($2n = 44$) while the common species is a tetraploid ($2n = 88$) (Olah & DeFilipps 1968).

DESCRIPTION OF SPECIES

Dodecatheon frenchii is a hairless perennial herb from a caudex surrounded by fleshy, mostly horizontal, adventitious roots and it lacks a leafy stem. The 4-10 leaves are generally 6-20 cm long, basal, simple, entire, broadly ovate, soft-fleshy, and abruptly contracted to a narrow petiole-like base. The inflorescence is a bracteate umbel at the top of a smooth, unbranched hollow stalk (scape) that generally measures 20-60 cm (Yatskievych 2000). The flowers are individually stalked (pedicels 1-3 cm long), pendulous, the petals are white or less frequently tinted pale rose to lilac, normally 2.0 -2.5 cm long, and they are strongly bent backward; the petals are fused at their yellowish bases and are marked with a dark purple ring at the base inside; the stamen filaments are unfused about half their length, the base of each of the five yellow anthers is auricled, and the tips converge around the pistil in a conical arrangement. The fruit is a capsule about 6 mm long that contains many tiny angular-shaped seeds (adapted from W-4, W-7, Gleason & Cronquist 1991, Mohlenbrock 1986, and Post 1996). The distinctive leaf shape, with its normally cordate blade above a narrow petiole-like base, makes this species quite easily recognizable whether fertile or not and distinct from the other species, which have a gradually narrowed leaf base (see also Olah & DeFilipps 1969).

HABITAT AND ECOLOGY

Dodecatheon frenchii is normally found in a very distinctive and limited habitat (Mohlenbrock 1978a). Typically, the plants grow in linear colonies in thin sandy soil in shade directly below the outer edges of prominently extending and overhanging sandstone ledges that are exposed along or near streams, though these can vary from small overhangs to large shelters. The sandstone cliffs or bluffs above are forested with species tolerant of drought conditions, and these not only prevent soil erosion from above but they also provide shade to the colonies (Voigt & Swayne 1955). The exposure is generally northern to eastern, and the plants rarely, if ever, are exposed to direct sunlight, at least at mid-day (Hauser *et al.* 1981). These areas are often called rock shelters or rock houses (Francis *et al.* 1993) because people have used these areas as protection from the weather since prehistoric times. Livestock have sometimes used these shelters for the same purpose, or people have sheltered their animals within them. Regarding shade requirements, Olah and DeFilipps (1969) recorded light readings of 14-25 % less than the 5000-6000 foot candles recorded within *Dodecatheon meadia* habitat.

Soil layers on which the plants grow are composed of sandy residuum or unweathered loess (Kurz & Bowles 1981). This soil has also been described as an organic-poor sandy regolith (loose, incoherent mantle of rock fragments, soil, blown sand, alluvium, etc., which rests upon solid rock, *i.e.* the bedrock) and which may concentrate salts (Timme & Lacefield 1991). The soil pH requirements are not known, but loess soils are often alkaline, and the concentration of salts may contribute to that. It can grow in alkaline sandy-clay soils in cultivation (Hill, pers.

obs.). The normally thin soil present is well-drained, but it must be moist or wet in the winter and spring during the plant's growing and reproductive season. The plants are well adapted to the drying of their habitat in the summer at which time they wilt and lose their leaves, which decompose rapidly, making them nearly impossible to find during their dormant season (starting in late June) except for the occasional persistence of a dried flower stalk. Some biologists might consider the species a pioneer species because of the occasionally disturbed habitat. However, the somewhat fleshy roots serve to store water and nutrients during the plant's dormancy and the individual plants appear to persist for years.

The species is very well adapted to this unusual and scarce habitat, and there are generally few other plants that are adapted to the habitat or that can grow with it. Therefore, there is little competition from other plant species and French's shootingstar often grows alone in bare soil. This is important, because the species is a delicate one, and it does not appear to be able to compete well with other plants. In cultivation, the plant must be grown on bare soil and other plants must be kept from it by a distance of about 20 - 40 cm (Hill, pers. obs.). In addition, the seedlings appear to need bare, moist soil with no competition to germinate and persist; this also includes a need for a lack of leaf litter which prevents seedling establishment (Timme & Lacefield 1991).

Associated plants have been recorded from several parts of the range of French's shootingstar. In Illinois, *Heuchera parviflora* Bartl. is a very common associate and useful indicator species along with *Hydrangea arborescens* L. *Parietaria pensylvanica* Muhl. ex Willd. is a common associate along with *Cardamine parviflora* L. var. *arenicola* (Britt.) O.E.Schulz, *Cardamine pensylvanica* Muhl. ex Willd., and *Samolus valerandii* L. in wet sites and *Chenopodium simplex* (Torr.) Raf. and *Sedum ternatum* Michx. can be associates in dry sites. Associated ferns include *Polypodium virginianum* L. and *Athyrium filix-femina* (L.) Roth (Hill, pers. obs.; Kurz & Bowles 1981; Hauser *et al.* 1981), and the club-moss *Lycopodium porophyllum* Lloyd & Underw. is said to be a reliable associate as well. Additional associated plants can include *Anemonella thalictroides* (L.) Spach, *Tiarella cordifolia* L., *Solidago caesia* L., and *Plantago* spp.

The sandstone cliffs where French's shootingstar grows are generally surrounded by forested land, composed generally of mesic upland forest or floodplain forest elements (White & Madany 1978) dominated by tall mature trees, primarily post oak, white oak, southern red oak, black oak, beech, maples, mockernut hickory, pignut hickory, and hop hornbeam (Timme & Lacefield 1991). In years with a wet spring, the colonies appear to prosper, but in years when the rainfall is less or if the temperatures elevate early, the plants may not be able to form fruits because of lack of sufficient moisture whereupon they become dormant early (Mohlenbrock 1978, Olah & DeFilipps 1969, Tucker 1982).

DISTRIBUTION AND ABUNDANCE

Dodecatheon frenchii is limited in range to an area mostly just south of the glacial boundary in only six Midwestern and southeastern states in the United States of America, namely, Alabama, Arkansas, Illinois, Indiana, Kentucky, and Missouri. The species has been reported to exist in Wisconsin, but this report has been shown to be based on specimen misidentifications (see below). Other erroneous reports have been made for Pennsylvania and Minnesota (Voigt & Swayne 1955). Additional details on the distribution of French's shootingstar can be found in

Mohlenbrock (1986), Mohlenbrock and Ladd (1978), Nelson (1979), Kartesz and Meacham (1999), Smith (1988), and Yatskievych and Turner (1990).

Dodecatheon frenchii was reported by Fassett (1927, 1944) and others for Wisconsin on the basis of two collections in WIS (s.d., *I.A. Lapham s.n.*; 27 Jun 1895, *W.R. Schuman s.n.*), both of which proved to be *Dodecatheon meadia* (see discussion in Iltis & Shaughnessy 1960).

French's shootingstar has been found in northwestern Alabama only in Colbert County, and these plants represent the most southerly distribution reported for the species (Timme & Lacefield 1991). It is associated with Hartselle sandstone of Mississippian age in the Cumberland Plateau physiographic province. In Arkansas, where it is listed as Threatened and is at its western range limit, *Dodecatheon frenchii* has been reported only from two counties, Newton (numerous occurrences) and Cleburne (one occurrence) (W-5, W-7). It is occasionally found in Newton County in large numbers in areas that have not been impacted by timber management (Tucker 1982). In Missouri, *Dodecatheon frenchii* was previously listed as endangered, but current law in the state only allows the listing of federally listed taxa as state endangered. It occurs only at one site, Hickory Canyons Natural Area in Ste. Genevieve County, about 137 km (85 mi) due west of Carbondale, Illinois, privately owned but managed by the Missouri Department of Conservation (Yatskievych, pers. com.). In Kentucky, where the species is listed as of Special Concern, French's shootingstar has been found in nine counties (Breckinridge, Carter, Crittenden, Edmonson, Hardin, Menifee, Todd, Union, Warren) in the northeastern and western portions of the state (W-5, W-7).

Within the U.S. Forest Service Eastern Region (Region 9) *Dodecatheon frenchii* has been confirmed to be present only within the Hoosier National Forest (IN) and the Shawnee National Forest (IL) and it has been included on the RFSS list for both.

In Indiana, all existing *Dodecatheon frenchii* populations are known from Crawford and Perry counties only (Hauser *et al.* 1981) and the species is state listed as Rare. The Indiana Heritage Data Center has records for 23 populations in the state, 21 of which are on the Hoosier National Forest. It is not known if all are still extant. In the Hoosier National Forest, the species is limited to a 4.8 km by 24.1 km (3 mi by 15 mi) area and a smaller area a few kilometers to the east (S. Olson, pers. com.).

In Illinois, where the species is most frequent, the populations have been reported within a 16 km (10 mi) wide belt, sometimes called the Shawneetown Ridge, in the extreme southern portion of the state (Voigt & Swayne 1955, Mohlenbrock & Ladd 1978, W-4) in six counties (Jackson, Johnson, Pope, Saline, Union, Williamson). These all fall within the Shawnee Hill Natural Division of Illinois, Greater Shawnee Hills Section (Schwegman *et al.* 1973). Because the species is not being tracked by the Natural Heritage unit of Illinois Department of Natural Resources, information on populations is to be found in herbaria and publications, as well as from botanists and Shawnee National Forest staff.

Some populations in Illinois and in the other states are individually large, some as large as 50 square meters, with hundreds of individuals present. The Indiana Heritage Data Center (INHDC 2001) has recorded population sizes varying from 1 plant at 3 sites, 11-50 plants at 7 sites, and

101-1000 plants at 6 sites, all 16 sites located within the Hoosier National Forest. Population sizes can vary from year to year depending upon temperature and rainfall conditions. The sandstone overhangs where they grow are typically along streams that flow southward (Voigt & Swayne 1955). Nevertheless, the populations, large or small, are isolated from one another because of its specific requirements for an uncommon and discrete habitat. Moreover, it can be difficult to decide what defines a ‘population’. Because of the isolated nature of the habitat, one could say that each colony under a cliff is a population, or else one could use a specific distance between colonies to distinguish populations, assuming that there is no pollen interchange over that distance. No final decision on this problem is attempted here.

PROTECTION STATUS

The Nature Conservancy currently lists *Dodecatheon frenchii* as a G3 plant, indicating that the species is globally vulnerable and uncommon to rare (W-5). In the United States the species is given the National Heritage rank of N3 with a similar meaning. The state rankings vary, but it has official designations as Threatened in Arkansas, Rare in Indiana, and of Special Concern in Kentucky.

In addition, *Dodecatheon frenchii* is listed on the U.S. Forest Service’s Regional Forester Sensitive Species list for both the Shawnee and Hoosier National Forests, and it is listed as Rare on Indiana’s Threatened and Endangered (T&E) Species list. It has not been included on the Illinois T&E list because of its greater frequency there. Official protection for the species outside of Forest Service lands depends upon state and local laws because it is also not listed as Federally threatened or endangered. Formerly the species was tracked by the U.S. Fish and Wildlife Service as a 3C species (USFWS 1993), a candidate for federal listing, but this category is no longer used.

Table 1 lists the official state rank assigned by each state’s Natural Heritage program according to the Nature Conservancy at their Internet site (W-5). Appendix 3 explains the meanings of the acronyms used (W-1). It should be pointed out that the species record for Wisconsin was based upon specimen misidentifications. A summary of the current official protection status for French’s shootingstar follows:

<u>U.S. Fish and Wildlife Service:</u>	Not listed (None)
<u>U.S. Forest Service:</u>	Region 9, Sensitive (both Illinois and Indiana)
<u>Global Heritage Status Rank:</u>	G3
<u>U.S. National Heritage Status Rank:</u>	N3

Table 1: S-ranks for *Dodecatheon frenchii* [element PDPRI03060]

<u>State</u>	<u>Heritage S-rank</u>
Alabama	S1
Arkansas	S2

Illinois	S3
Indiana	S2
Kentucky	S3
Missouri	S1
Wisconsin	SR

LIFE HISTORY

Dodecatheon frenchii is a perennial herb but its average life-span is not known. Like its relatives, it can produce additional rosettes from the same rootstock in age, but these do not spread the plant naturally, they merely help insure an individual's survival and increase reproductive potential through additional inflorescences.

Plants begin growth in late winter or early in the spring. According to Biotic Consultants (1976) the average date for the appearance of the first leaf is between the 13th and 28th of February. Individual plants may form as many as 10 basal leaves. Flowering occurs as early as mid-March and can continue until late April. In Alabama flowering takes place from mid-April to mid-May (Timme & Lacefield 1991). In southern Illinois, flowering has been observed to occur between March 14 and April 27 (Mohlenbrock 1978). An individual plant can produce up to 15 flowers, but the total is normally less. Cultivated individuals in Champaign, Illinois were seen to open their first flowers on April 28 and these were open until May 31, the peak being on May 10 (Hill, pers. obs.). It may be of some value to note that *Dodecatheon meadia* was seen to flower from April 11 to May 31 at the same location, but these data are preliminary. An additional observation has been that it requires at least two to three years for a plant to produce its first flowers. The plant is not secure until it has developed a large root mass that can withstand drought. After fertilization, the developing fruits are raised vertically as the old flower stalk straightens. Seed capsules begin to form before the petals have withered away, as in related species. By the end of May, leaves generally have begun to turn yellow and fruits are about mature (up to 6 mm in length). Seeds mature by the end of June and begin to fall immediately after the capsule splits, though some may be shed through late summer. By early July, most plants have become dormant (Biotic Consultants 1976).

While there may be speculation that a seed bank is built up on site for this species, there seems to be no evidence in the literature for this. The seeds are very small, their seed coat does not appear to be thick, and my personal opinion is that the species does not persist for long periods in the seed bank. Instead, it appears to me that the persistence of the tough root mass and its protected subsurface bud(s) is crucial to the species' survival, and that the production of numerous seeds per capsule allows seedling establishment in favorable years only.

Further details on life history, and particularly on viability, follow in the next section.

POPULATION BIOLOGY AND VIABILITY

Few observations have been made on the pollinators of this species, but several have been conducted for related species within the genus. The fact that a percentage of flowers do not form fruits (Hill pers. obs.) suggests that cross-pollination is necessary for successful reproduction.

The only insects that have been observed visiting *Dodecatheon frenchii* flowers have been very small flies and some small bees (Tucker 1982). In a study of the pollination ecology of the closely related *Dodecatheon amethystinum*, small bees and flies were frequently seen visiting the flowers, but none were actually involved with the pollination of the plants (Macior 1970). The only effective pollinators of *D. amethystinum* were the queens of *Bombus affinis*, *B. griseocollis*, *B. impatiens*, *B. vagans*, and *B. nevadensis auricomis*, with the exception of *Bombus bimaculatus*, where queens and drones were equally effective (Macior 1970). In addition, the sweat bee *Augochloropsis metallica* has been recorded as a buzz-pollinator (a specialist that vibrates poricidally dehiscent anthers like those of shootingstars to gather pollen) on *Dodecatheon* (Macior 1964). Similar results might be expected with further observations on French's shootingstar.

Dodecatheon frenchii is a diploid ($2n = 44$) while the more common and widespread *D. meadia* is a tetraploid ($2n = 88$). Hybrid sterility is likely a barrier to interbreeding between the two species, which occasionally grow in close proximity. Individuals of both species show a high stainability of pollen (indicating fertility). It would appear that both species are reproductively healthy and kept distinct from one another by means of their incompatible chromosome numbers (Olah & DeFilipps 1968). However, the genetic variability within French's shootingstar has not been studied, though at least one study is in progress.

The species appears to establish successfully from seeds scattered in the vicinity of the parent plants. Each fully developed capsule is capable of producing at least 100 tiny seeds. As pointed out above, unlittered seasonally moist mineral soil appears to be necessary for seedling establishment. The small size of the seeds may allow them to be blown by winds capable of lifting sand and dust or they may occasionally be carried by water flow. No other dispersal agents are known, but ant-lions and ants have been observed in close proximity to the plants (Tucker 1982). It is not known if they play a role in the dispersal of its seeds. There appears to be very high seedling mortality based upon the simple fact that the plants are quite fertile and produce many seeds, but there are rather few plants that live to adulthood. The seedlings and plants themselves are very delicate and easily crushed and killed by trampling. The incidental digging and trampling of plants during searches by artifact hunters is thought to pose a great threat to the species (Olson 1999, Starkey 2001), but any activity on these ledges poses a threat to it. There is also some speculation, but little data, that browsing by deer and other animals may have had adverse affects on populations, especially on seed production (W-5).

As stated above, some populations of this species particularly in Illinois and Arkansas, while very local, are individually large, some as large as 50 square meters, with hundreds of individuals present. Nevertheless, the populations, large or small, are isolated from one another because of its specific requirements for an uncommon habitat. The species appears to be stable and viable throughout its range at this time, especially in Illinois, and most of the populations are protected within conservation areas or national forests (Olson 1999). However, it is also thought that mechanical damage, drying, and erosion has eliminated some populations of the plant, and that this may continue (Shimp, pers. com.; Starkey 2001).

Suitable habitat for the species occurs only along a narrow band in the area of the Shawnee Hills where there appears to be additional suitable habitat for the plant available. While it is thought

that most significant sized populations have been found because the habitat is a very popular one among hikers and botanists, additional searches are suggested. With proper habitat management, the populations should persist.

POTENTIAL THREATS

Overall, this species is relatively secure. However, its habitat is not common and French's shootingstar cannot stand some types of disturbance. The threats to the species include physical damage from trampling (humans and animals), browsing of leaves and reproductive parts (especially flower buds) by wildlife, erosion (including both a loss of sediment from the sandstone ledges as well as an influx of smothering deposits), and drying, the latter two as a result of logging or other cutting of the mature trees that shade these unusual habitats.

Botanists generally believe that most native plants have reached the limit to which they can travel under present conditions of climate (that is, temperature and rainfall), substrate, dispersal mechanism, and other pertinent factors. In other words, species are in balance with their environment as long as the environment is stable. In many biological simulations, ecological extremes are more important than the means in controlling plant distribution (Webb *et al.* 1975). An obvious example is that of frost tolerance (temperature extremes). A plant species completely intolerant of freezing can persist in a site indefinitely until the first time extreme temperatures cause it to freeze. One such freeze in a century may be enough to eliminate a species entirely from a wide area of its range, and changes in climate historically have caused the greatest changes in plant distributions.

In the case of *Dodecatheon frenchii*, current distribution appears to be dependent primarily on historical factors (lack of glaciation within its current range, resulting in a 'relict' distribution), substrate and bedrock type, and age of surrounding forest as well as the degree of canopy closure rather than from temperature extremes. With limited means of seed dispersal, it may also be unable to increase its range very quickly. The climatic factor of winter and spring moisture appears to be crucial, along with a stability of soil and lack of competition. Under natural conditions, these habitats are stable, but if trees surrounding the ledges are cut or if human or animal traffic increases, the fragile habitat balance can be destroyed and the populations can be lost. The use of fire as a management tool does not appear to be a beneficial factor for this species; the ledges actually provide some protection from natural fires and a combustible component is not part of its immediate environment. Burning of the surrounding forest or that forest on the bluffs above might be detrimental by increasing both light and erosion.

Habitat fragmentation can have profound effects on the success and persistence of local populations. Any activities that result in barriers to dispersal, such as developments, clearcuts, road/utility line corridors, and mined areas limit the possibility of population expansion and genetic exchange in many species. Deleterious effects of fragmentation could possibly go unnoticed for a long period of time, making the short term effects on species viability less apparent. Over time, as populations become increasingly more isolated, the effects of fragmentation can potentially be observed at the molecular level by reduced genetic frequencies caused by random drift (Barrett & Kohn 1991). When one is considering populations that are already naturally isolated, as in the case of French's shootingstar, random genetic drift may have

already occurred. In fact, this may have been a driving force in its evolution as a distinct species.

Complete clearing or cutting of a forest stand would appear to eliminate *Dodecatheon frenchii*, and therefore such practices could not be enacted where a colony occurs without adverse effects. Many of the best-known colonies of the plant occur near well-used trails and it is thought that this has had negative effects on them. Restricted access to the sites, relocation of the trails (especially equestrian trails) and complete elimination of logging, camping, rock climbing, off trail vehicles, and fires in areas where it grows would be indicated as a means to ensure the species' survival and viability (Starkey 2001). Most of these activities are currently illegal where this species grows in the Shawnee National Forest. This protection program has been considered at the Daniel Boone National Forest where the species occurs in eastern Kentucky (e.g., Biebighauser 2001, W-3).

The protection of rock shelter habitats from artifact hunters coupled with more enforcement of this protection is needed. Upland and surrounding forest protection is a requirement to buffer sites from the effects of erosion and drying and to provide shaded light levels which may influence long-term viability. Increased management and control of deer herds may be needed in some areas.

At the current time, it does not appear that the populations of *Dodecatheon frenchii* in the Hoosier or Shawnee National Forests are immediately threatened with elimination because of habitat loss. However, in the absence of future management of the forest and sandstone ledges and shelters for this species, it could decrease or be eliminated.

RESEARCH AND MONITORING

According to George Yatskievych (pers. comm.), Tim Rye, a Master's student at the University of Missouri at St. Louis, will be looking at the relationship between *Dodecatheon frenchii* and *D. meadia* using molecular techniques in the near future.

French's shootingstar is being monitored by botanists working on behalf of the state Natural Heritage programs and other organizations in the areas where it is listed as rare, threatened, or of special concern (W-5). However, a continuing problem is that there is neither sufficient funding nor are there enough botanists available to survey the immense area that needs to be covered in the monitoring of the large numbers of sensitive plants, including this one (Hill 2002). There is the potential of additional suitable habitat in extreme southern Illinois where *Dodecatheon frenchii* could exist, and continued searches for the species could be conducted.

In addition to the basic effort of locating additional populations of the species, it would be useful to conduct a genetic investigation of the diversity among and between the colonies to determine the genetic diversity present for the species. Because of its diploid chromosome number and the relict nature of its habitat and distribution, the species may prove to be of ancient origin and relationships. The studies of T. Rye mentioned above may shed light on these speculations. The techniques for these and other aspects of monitoring and studying rare plant species are explained well in Collins *et al.* (2001), Philippi *et al.* (2001), and Imm *et al.* (2001).

Of particular importance is the monitoring of the same populations over time to determine population dynamics. Also, more research is needed on the longevity of individuals and the establishment of seedlings. Particular attention must be shown to avoid invasive monitoring (trampling) of the sites. It might be useful to enclose some colonies within fencing to investigate the effects and influence of excluding browsers and to test the effectiveness of this kind of protection.

The Hoosier National Forest has instituted an agreement with the Indiana Department of Natural Resources, Division of Nature Preserves, to conduct surveys of rare and exotic plants in special areas. The populations of rare plants are to be documented, former sites revisited, and plot information collected, and each exact location is to be noted with Global Positioning System technology. As of 2000, two of the approximately 21 known sites for *Dodecatheon frenchii* had been rechecked and two new sites for the plant had been discovered (Day 2000).

RESTORATION

There are no known restoration efforts being conducted on *Dodecatheon frenchii* anywhere in its range. Most research on the species has been conducted to determine if it is a valid species or not. This matter appears to have been settled, and monitoring has been instituted only in relatively recent times. However, the elimination from consideration and listing of most Candidate species from the U.S. Fish & Wildlife Service's Federally Listed Endangered, Threatened, and Candidate Species monitoring programs (*e.g.*, W-8) has resulted in less attention being paid to this and other similarly listed plants. More data is needed on these species and the listing in the RFSS list should help in this regard. The National Forests in Illinois and Indiana also are the greatest hope for the protection of this narrowly distributed United States endemic plant.

Nursery grown plants are occasionally available, and a brief Internet search found French's shootingstar for sale by the New England Wild Flower Society's Garden in the Woods (Massachusetts). <http://www.newfs.org/catalog.htm>. Their catalog entry follows:

Dodecatheon frenchii (Shooting Star) Another rare and rarely available species and one that deserves wider use. Satisfying Shooting Star with light green, ruffled leaves and pure white flowers with a yellow center. Compact and lovely. Height: 10-14 in; Bloom: May; Color: White/yellow; Light: w; Soil: Moist; Range: Eastern US; Zone: 5-9. RARE GLOBALLY.

Otherwise, this plant seems to be generally unavailable commercially.

Restorations of any native plant species are recommended using only nursery propagated material grown from native, local populations to avoid interbreeding with genotypes not adapted to the local conditions and to avoid compromising the local gene pool. If this rule is not followed, the result is generally the loss of plants because they are not competitive under local conditions or the result could be the success of a plant or plants that can not be considered truly native (considered by some to be a plant community reconstruction rather than a restoration). The planting of French's shootingstar in Illinois from unknown seed sources would not be

encouraged in a restoration effort. Local plants should, instead, be propagated for planting in such an effort.

SUMMARY

Documented as native only in six Midwestern and southeastern states, *Dodecatheon frenchii*, French's shootingstar, is found only in the United States. It is currently secure, but its very narrow and restricted habitat preferences make it vulnerable for extirpation in several states if the habitat is not managed. Its distribution within its range is limited primarily by its preferences for shaded, seasonally moist, protected pockets under sandstone ledges just south of the glacial boundary. It does not appear to have reproductive problems, but its dispersal means are limited. French's shootingstar is vulnerable to physical trampling by humans and animals, browsing by animals, the effects of erosion, drying due to the loss of surrounding forests, and incidental destruction by campers and artifact hunters. French's shootingstar was formerly listed as a Federal Candidate species by the U.S. Fish and Wildlife Service and is currently listed as Threatened in Arkansas, Rare in Indiana, and of Special Concern in Kentucky. It is listed currently as a Regional Forester Sensitive Species in the Shawnee and Hoosier National Forests. Casual access to the vicinity of the populations should be limited. Continued population monitoring is needed and searches should be conducted for additional populations in far southern parts of the state in suitable habitat. Management through protection of its habitat and through possible exclosures may be needed for it to persist at its present locations, which are currently secure.

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W-2. The Historic G.H. French Herbarium Database, Southern Illinois University

<http://www.science.siu.edu/herbarium/database/ghfherb.htm>

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W-4. Illinois Plant Information Network (ILPIN)

<http://www.fs.fed.us/ne/delaware/ilpin/286.co>

W-5. NatureServe (The Nature Conservancy)

[_http://www.natureserve.org/](http://www.natureserve.org/)

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APPENDICES

Appendix 1

Natural Diversity Database Element Ranking System

modified from: <http://www.cnpsci.org/html/PlantInfo/Definitions2.htm> [W-1]

Global Ranking (G)

G1
Critically imperiled world-wide. Less than 6 viable elements occurrences (populations for species) OR less than 1,000 individuals OR less than 809.4 hectares (ha) (2,000 acres [ac]) known on the planet.

G2
Imperiled world-wide. 6 to 20 element occurrences OR 809.4 to 4,047 ha (2,000 to 10,000 ac) known on the planet.

G3
Vulnerable world-wide. 21 to 100 element occurrences OR 3,000 to 10,000 individuals OR 4,047 to 20,235 ha (10,000 to 50,000 ac) known on the planet.

G4
Apparently secure world-wide. This rank is clearly more secure than **G3** but factors exist to cause some concern (i.e. there is some threat, or somewhat narrow habitat).

G5
Secure globally. Numerous populations exist and there is no danger overall to the security of the element.

GH
All sites are historic. The element has not been seen for at least 20 years, but suitable habitat still exists.

GX
All sites are extirpated. This element is extinct in the wild.

GXC
Extinct in the wild. Exists only in cultivation.

G1Q
Classification uncertain. The element is very rare, but there is a taxonomic question associated with it.

National Heritage Ranking (N)

The rank of an element (species) can be assigned at the national level. The **N-rank** uses the same suffixes (clarifiers) as the global ranking system above.

Subspecies Level Ranking (T)

Subspecies receive a **T-rank** attached to the G-rank. With the subspecies, the G-rank reflects the condition of the entire species, whereas the T-rank reflects the global situation of just the subspecies or variety.

For example: *Chorizanthe robusta* var. *hartwegii*. This plant is ranked **G2T1**. The G-rank refers to the whole species range (i.e., *Chorizanthe robusta*, whereas the T-rank refers only to the global condition of var. *hartwegii*. Otherwise, the variation in the clarifiers that can be used match those of the G-rank.

State Ranking (S)

S1

Critically imperiled. Less than 6 element occurrences OR less than 1,000 individuals OR less than 809.4 ha (2,000 ac). **S1.1** = very threatened; **S1.2** = threatened; **S1.3** = no current threats known.

S2

Imperiled. 6 to 20 element occurrences OR 3,000 individuals OR 809.4 to 4,047 ha (2,000 to 10,000 ac). **S2.1** = very threatened; **S2.2** = threatened; **S2.3** = no current threats known.

S3

Vulnerable. 21 to 100 element occurrences OR 3,000 to 10,000 individuals OR 4,047 to 20,235 ha (10,000 to 50,000 ac). **S3.1** = very threatened; **S3.2** = threatened; **S3.3** = no current threats known.

S4

Apparently Secure. This rank is clearly lower than S3 but factors exist to cause some concern (i.e., there is some threat, or somewhat narrow habitat).

S5

Secure. Demonstrably secure to ineradicable in the state.

SH

All state sites are historic; the element has not been seen for at least 20 years, but suitable habitat still exists. Possibly extirpated.

SR

Reported to occur in the state. Otherwise not ranked.

SX

All state sites are extirpated; this element is extinct in the wild.

Notes:

1. Other considerations used when ranking a species or natural community include the pattern of distribution of the element on the landscape, fragmentation of the population/stands, and historical extent as compared to its modern range. It is important to take a bird's eye or aerial view when ranking sensitive elements rather than simply counting element occurrences.
2. Uncertainty about the rank of an element is expressed in two major ways: by expressing the rank as a range of values (e.g., **S2S3** means the rank is somewhere between S2 and S3), and by adding a ? to the rank (e.g. S2?). This represents more certainty than S2S3, but less than S2.

APPENDIX 2

Representative specimens of *Dodecatheon frenchii* examined

Herbaria:

ILLS = Illinois Natural History Survey Herbarium, Champaign. SIU = Southern Illinois University Herbarium, Carbondale. WIS = University of Wisconsin Herbarium, Madison.

ARKANSAS: CLEBURNE CO., sec. 22, T12N, R10W, Prim 7.5' quad. Along Clifty Creek, ca. 2.0 miles E of Woodrow, 13 May 1985, *Orzell 1854* (photo of specimen in Univ. ARK - Fayetteville at WIS!); NEWTON CO., sec. 26, T14N, R22W, Swain 7.5' quad., ca. 1.75 mi NW of Nail along W to E flowing tributary to Dismal Hollow within the Ozark National Forest, 15 May 1984, *Orzell 1326*, (photo of specimen in Univ. ARK - Fayetteville at WIS!).

NOTE: No specimens were seen from Saline or Williamson County, Illinois.

ILLINOIS: JACKSON CO., Giant City State Park, T10S, R1W, sec. 27, 12 May 1951, *Bailey & Swayne 1382*, (WIS! ex SIU); Giant City State Park, Makanda, 14 May 1937, *Wadmond, Fassett, Curtis, & Dunlop 18585* (WIS!), *18591* (WIS!), *18593* (WIS!), *22161* (WIS!); Giant City State Park, 17 May 1952, *Voigt 1197* (WIS! ex SIU); Midland Hills, 9 May 1951, *Voigt s.n.*, (WIS! ex SIU); Midland Hills Country Club, T10S, R1W, sec. 18, 3 Jul 1951, *Bailey & Swayne 1505* (WIS! ex SIU); Gorham, 14 May 1937, *Wadmond, Fassett, Curtis, & Dunlop 18589* (WIS!); Hollow Natural Area, 11 Apr 1986, *Smith 722* (ILLS); Little Grand Canyon, 20 Jun 1956, *Buser 6413* (ILLS); Midland Hills Club, 9 May 1951, *Voigt 552* (ILLS); W of Forest Service Roadside picnic area, 1 May 1981, *Moran 1399* (ILLS); JOHNSON CO., The Jug along Little Cache Creek, W of Sanburn, T12S, R3E, sect. 5, 29 May 1952, *Bailey & Swayne 2401* (WIS! ex SIU); Fern Cliff State Park, T11S, R2E, 19 Jul 1951, *Bailey & Swayne 1583* (WIS! ex SIU); Ferne Clyffe, 19 Jul 1951, *Voigt 839* (WIS! ex SIU); SW of Goreville, 14 Jun 1949, *Evers 17558* (ILLS); Borax Cave, W of Goreville, 11 Jun 1950, *Evers 23718* (ILLS); Burnside Township, E of Reynoldsburg, 28 Mar 1961, *Evers 68354* (ILLS); 2 mi. S of Ozark, 14 May 1963, *Evers 75986* (ILLS); Benson's Bluff, SE of Goreville, 10 Apr 1969, *Evers 98583* (ILLS); S of Goreville, 1 May 1969, *Evers 98696* (ILLS); Benson's Bluff, SE of Goreville, 11 Jun 1968, *Evers 94967* (ILLS); SW of Tunnel Hill, 10 July 1963, *Evers 77004* (ILLS); POPE CO., Bell Smith Springs, 21 Jul 1951, *Voigt 842* (WIS! ex SIU); Cedar Creek Valley, Buffalo Rock Shelter, NW of Simpson, T12S R4E sect. 3, 16 Jun 1952, *Bailey & Swayne 2526* (WIS! ex SIU); Jackson Hollow, NW Pope Co., T11S, R4E, sect. 31, 14 May 1951, *Bailey & Swayne 1379* (WIS! ex SIU); Jackson Hollow, 28 Apr 1951, *Hatcher & Stewart s.n.* (WIS! ex SIU); Indian Kitchen area, Lusk Creek, T11S, R6E, sec. 34 along Bear Branch Creek, 21 May 1952, *Bailey & Swayne 2347* (WIS! ex SIU); Jackson Hollow Natural Area, T.11S, R.5E, Sect.31; T.12S, R5E, Sect. 6, 11 Apr 1986, *Smith 722* (ILLS); N section of Jackson Hollow, SW of McCormick, 13 May 1963, *Evers 75968* (ILLS); Jackson Hollow, SW of McCormick, 21 May 1969, *Evers 99361* (ILLS); Jackson Hollow, SW of McCormick, 1 May 1969, *Evers 98663* (ILLS); Bell Springs, SE of McCormick, 15 Apr 1949, *Evers 15806, 15811* (ILLS); Jackson Hollow, SW of McCormick, 22 May 1952, *Evers 33211, 33217* (ILLS); Bell Smith Springs, SE of McCormick, 29 Jun 1954, *Evers 44351* (ILLS); Bell Smith Spring, SE of McCormick, 23 May 1956, *Evers 49744* (ILLS); 3 mi. SW of McCormick, 4 May 1955, *Buser 3870* (ILLS);

UNION CO., Wing Hill, 2.5 miles E of Cobden, T11S, R1W, sec. 27, 18 Jul 1951, *Bailey & Swayne 1582* (WIS! ex SIU); E of Cobden, T11S, R1E, sect. 23, 16 Jun 1952, *Bailey & Swayne 2560* (WIS! ex SIU); 2-3 miles north of Saratoga, 20 Jun 1952, *Voigt & Swayne 1168* (WIS! ex SIU); Crab Orchard National Wildlife Refuge, Devil's Kitchen Research Natural Area, T11S, R1E, Sec. 3, 8 May 1983, *Ulaszek 171* (ILLS).

NOT IN WISCONSIN. All specimens at WIS filed as *Dodecatheon meadia* ssp. *membranacea*, some were called *D. meadia* var. *brachycarpum*, but H.H. Iltis accepts that as good species, related to *D. dentata* of NW USA. One folder of specimens of cultivated plants transplanted from Giant City Park, IL $2n = 44$. All specimens of this taxon at WIS from L.